Vol. 85, No. 40, pp. 469–480 30 December 1972

PROCEEDINGS
OF THE
BIOLOGICAL SOCIETY OF WASHINGTON

STUDIES ON POLLEN MORPHOLOGY IN THE VELLOZIACEAE

By Edward S. Ayensu
Smithsonian Institution
Washington, D. C. 20560

The family Velloziaceae contains about 250 species of perennial herbs and shrubs. Three or four genera are recognized from Madagascar, Southern Africa, Arabia, and South America. *Vellozia*, which is the type-genus, has the largest number of species (about 170); *Barbacenia* is the second largest genus with about 80 species. *Xerophyta* constitutes all the Madagascan and African species except for one, *Talbotia elegans* Balfour, which occurs in South Africa (cf. Smith and Ayensu, in press).

In recent years there has been heightened interest in the Velloziaceae because of their phytogeographical and evolutionary implications (Ayensu, in press). A treatment of the American species by Smith (1962) brought the family up to date, and since that time I have been studying the vegetative anatomy of the family with the intent of amassing further data to improve the systematics of the group (cf. Ayensu, 1968; 1969a, b). One of the problems in this family is how to resolve the highly controversial generic limits of the taxon.

The aim of this study, therefore, is to add new positive correlative information from pollen morphology to the existing characters that have been building up in recent years. Erdtman (1963) described the pollen of the Velloziaceae as being 1-sulcate of two distinct types, *Barbacenia-Barbaceniopsis* consisting of single grains while *Vellozia* grains are united in tetrads. *Barbacenia* grains are also smaller than those of *Vellozia*, in fact, in a ratio of about 1:2. His study was based on 16 species from both Africa and South America. A more

extensive study involving about 44 species was undertaken by Maguire (1969), also using the light microscope. Both studies showed that *Barbacenia* pollen grains are simple, ellipsoidal, and 1-sulcate with exine reticulations. *Vellozia* grains, on the other hand, are united tetragonal tetrads and nonsulcate.

The Old World species so far investigated by Erdtman (1963) and Maguire (1969) do not conform to the *Vellozia-Barbacenia* pollen breakdown which occurs in the American species. Maguire (1969) indicated that the pollen grains of the six American species he investigated were simple, ellipsoidal, 1-sulcate with a reticulate exine which was very similar to the American *Barbacenia* species. He therefore surmised that "It is not unreasonable, therefore, to suspect that all African elements belong neither to *Barbacenia* nor to *Vellozia*."

Attempts to classify the Velloziaceae genera on the basis of floral morphology have always been difficult because of intergradations that characterize the species (Smith and Ayensu, in press). This work represents the beginning of a pollen morphological survey of the Velloziaceae principally with the aid of scanning reflection electron micrographs. I have decided to use the SEM to survey the pollen in this family because it represents a rapid means of observing pollen wall surfaces coupled with a much greater resolution than the light microscope. Furthermore, very little work is required in the preparation of pollen grains to obtain satisfactory results with this instrument.

Materials and Methods: Pollen samples were removed from recently collected herbarium vouchers and put on a micro cover glass which was in turn placed on a specimen stub. The grains were suspended in a drop of absolute alcohol on the cover glass. The slight alcohol on the grains evaporated within a few seconds. There was no need for acetolysis or staining. The stub holding the micro cover glass and grains was rotated under pressure in high vacuum and coated with gold plating approximately 200^{A} thick.

Pollen grains of some monocotyledons have a tendency to collapse readily, and it is therefore necessary to take special precautions before the specimens are subjected to coating. In the Velloziaceae I observed that *Barbacenia* grains are much

sturdier than those of *Vellozia*. The following reasoning may be a contributing factor to the difference. *Barbacenia* grains are unisulcate, small-sized, and seem to maintain a turgid posture even under very dry conditions. *Vellozia* grains, on the other hand, are in united tetrads, nonsulcate, about twice the size of *Barbacenia* grains, and appear to collapse quite easily under extreme desiccation or pressure.

It was also observed that specimens fixed in formalin-acetic acid-alcohol (FAA) did not produce satisfactory results. The fixative seemed to dissolve some of the waxy substance on the grain surface, thus leaving a slimy coating which obscured the sculpturing on the grains. Furthermore, fixed materials seemed to explode and collapse much more easily under pressure in high vacuum.

Current experience shows that freshly dried specimens give the best results. More experimentation will be needed before conclusive statements can be made on the preparation procedures that will ensure optimal results.

The following specimens collected in Brazil were examined for this investigation. *Vellozia abietina* Mart. (Irwin et al. 20672); *V. crassicaulis* Mart. ex Schult. f. (Irwin et al. 15520); *Barbacenia gentianoides* Goeth and Henr. (Irwin et al. 22533); *Barbacenia magalhaesii* L. B. Smith (Irwin et al. 20972); *B. stenophylla* Goeth and Henr. (Irwin 9901).

I am very grateful to Dieter Wasshausen and Walter Brown for their technical assistance in the preparation of the above specimens.

Observations: This paper represents the beginnings of a catalogue of stereoscan photomicrographs of Velloziaceae pollen. The few photomicrographs accompanying this paper seem to suggest that further studies along these lines will achieve two objectives. Firstly, the definition of the two major genera —*Vellozia* and *Barbacenia*—will eventually be clearly delimited. Secondly, the detailed structure of the exine patterns will provide species-specific characters that are not easily discerned with a light microscope. If one compares the results achieved with the light microscope (cf. Maguire, 1969) and the photomicrographs in this paper, the superiority of the scanning electron microscope will be immediately obvious.

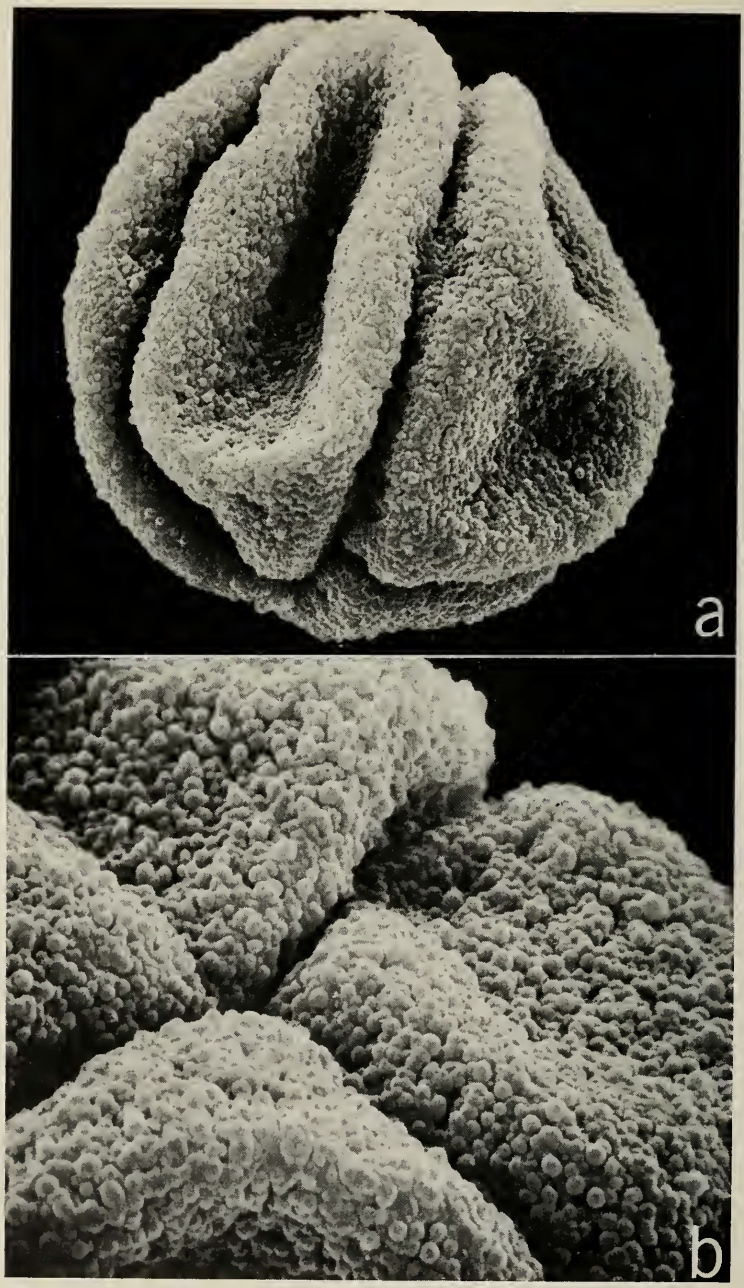

FIG. 1. *Vellozia abietina.* a. Oblique view. × 2,000. b. Polar view of tetrad. × 5,000.

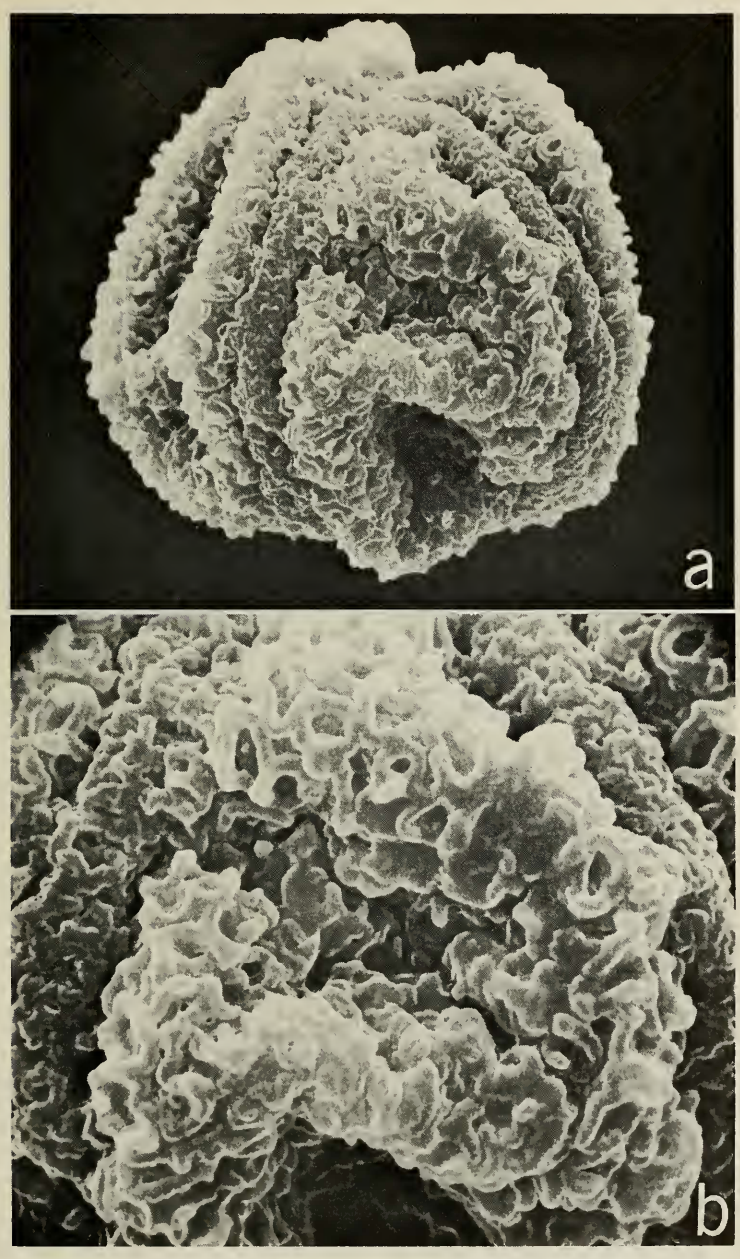

Fig. 2. *Vellozia crassicaulis.* a. Showing three side views. × 1,500. b. Details of a side view showing appressed vermiform-reticulations. × 3,000.

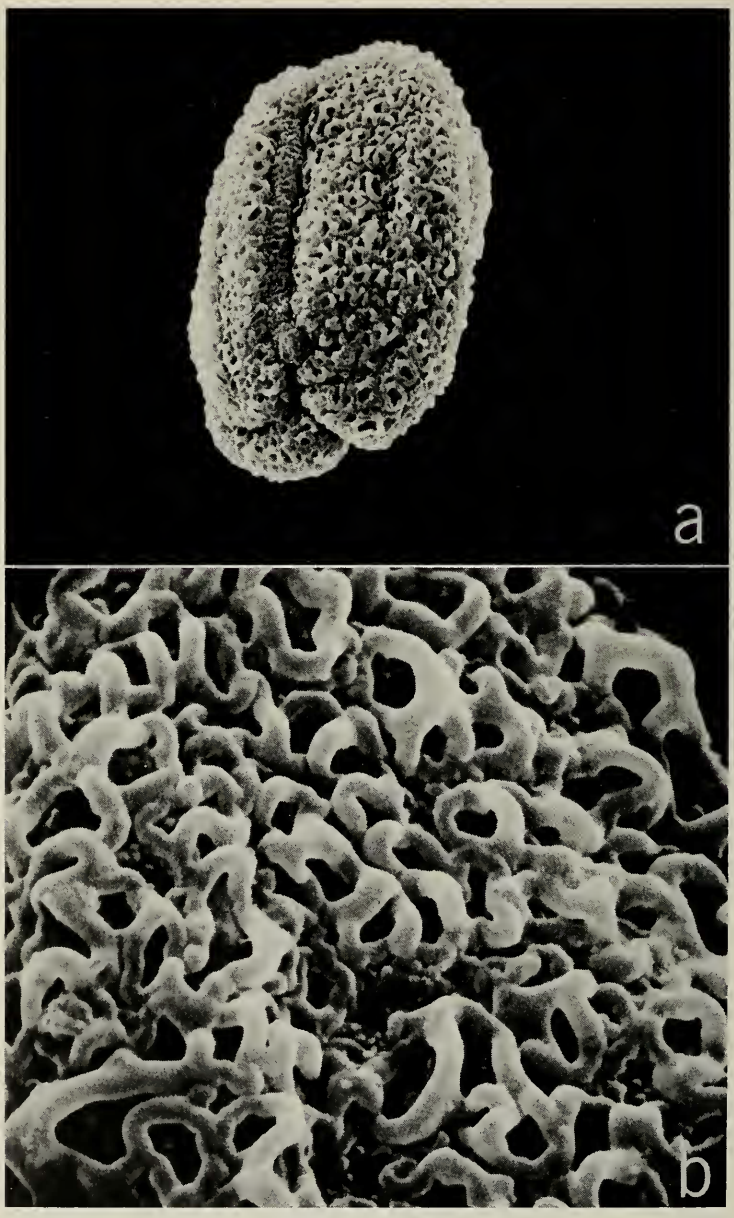

Fig. 3. *Vellozia flavicans.* a. Oblique view of tetrad. × 1,000. b. Details of a side view showing vermiform reticulations. × 5,000.

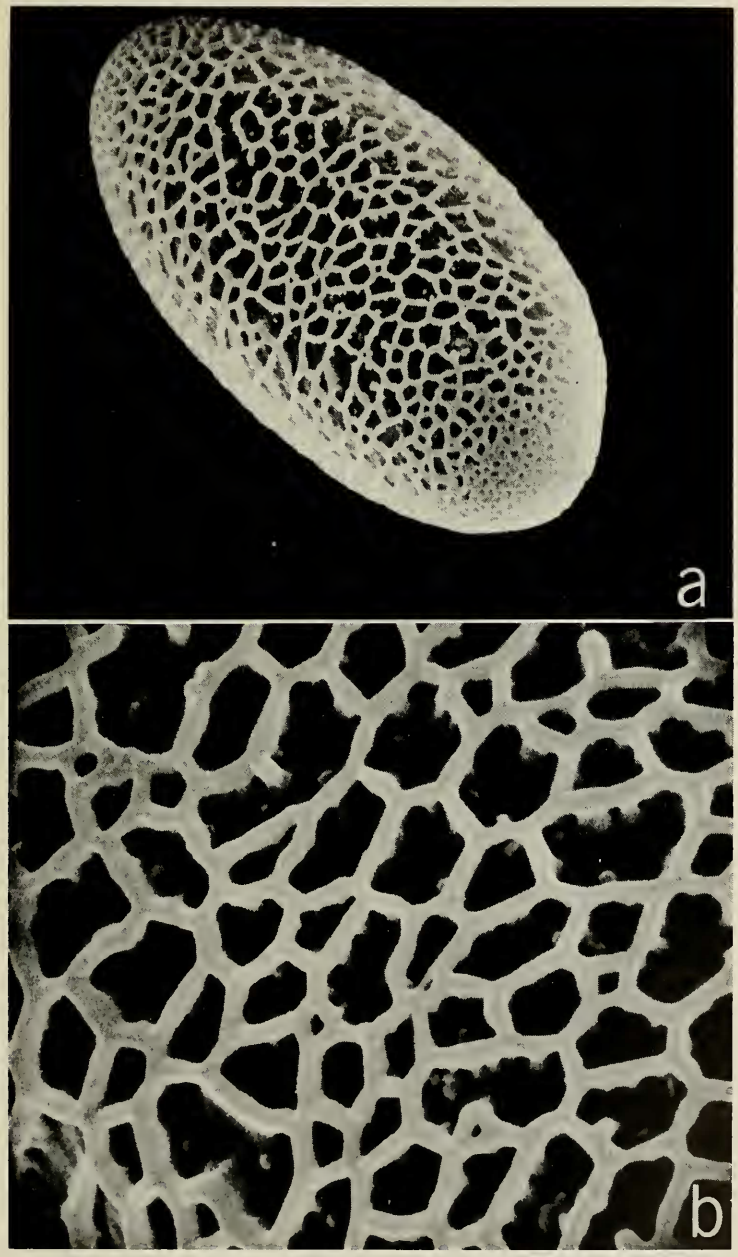

FIG. 4. *Barbacenia gentianoides*. a. Equatorial view showing reticulate exine. × 3,000. b. Side view showing sporoderm detail. × 10,000.

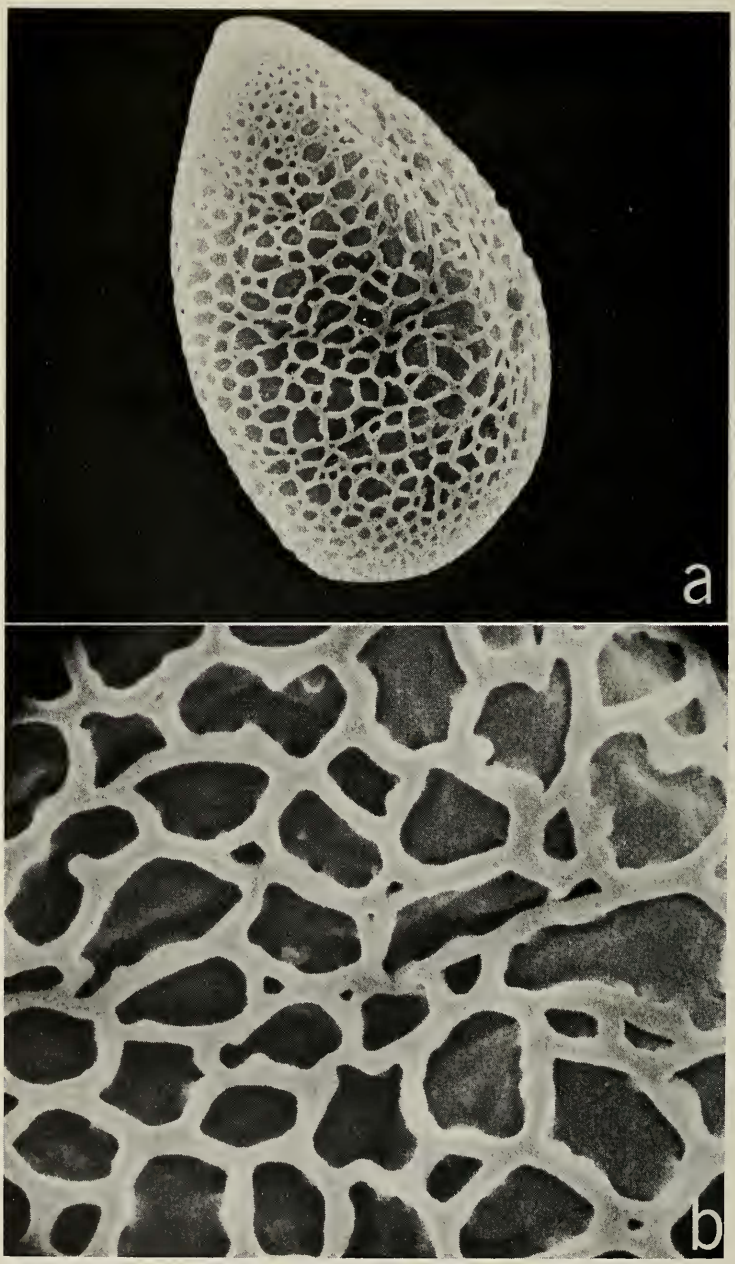

FIG. 5. *Barbacenia magalhaesii.* a. Equatorial view showing detail of reticulate exine. × 2,600. b. Side view showing sporoderm detail. × 10,000.

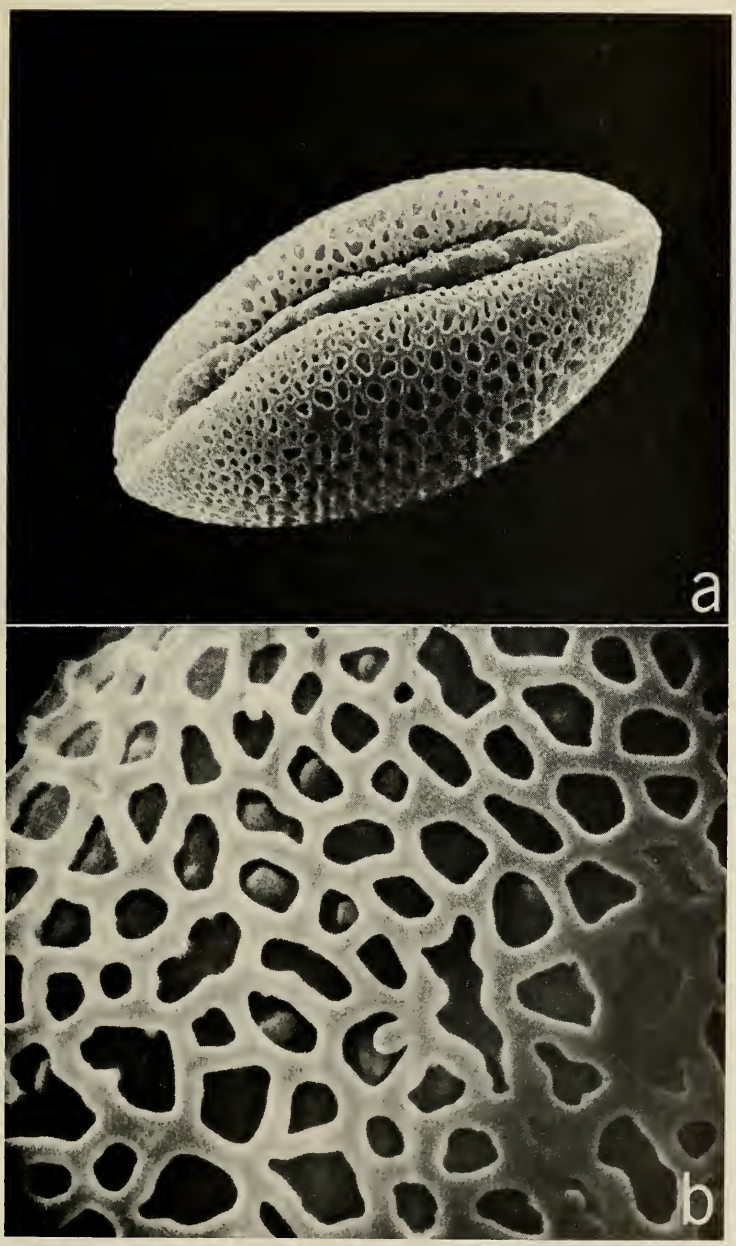

FIG. 6. *Barbacenia stenophylla.* a. Distalipolar view showing sulcus. × 3,000. b. Side view showing sporoderm detail. × 10,000.

My studies have confirmed the coherent, tetragonal tetrad nature of *Vellozia* pollen which Maguire (1969) illustrated; however, distinct variations among *Vellozia* species are clearly evident in the photographs (Figs. 1–3).

The exine sculpturing of *Vellozia* is often described as being reticulate or vermiform-reticulate (cf. Maguire, 1969). The exine of *Vellozia abietina* (Fig. 1a, b) can hardly fit this stereotyped exine sculpturing of *Vellozia* pollen wall. In fact, the sculpturing of *V. abietina* is neither reticulate nor vermiform-reticulate. It can be easily observed from Figure 1 that the exine of *V. abietina* is compactly multibaculate. The exine sculpturing of *V. crassicaulis* (Fig. 2) and *V. flavicans* (Fig. 3) are both vermiform-reticulate. However, the two species can be easily distinguished from each other by the form and size of the pollen grains as well as the degree of vermiculation.

Barbacenia pollen, on the other hand, is easily identifiable because of its simple, ellipsoid, unisulcate structure. But again it is clearly observed that there is variation in the reticulate exine sculpturing which characterizes the pollen walls of *Barbacenia* species (Figs. 4–6). The lumina of *Barbacenia gentianoides* (Fig. 4) are smaller than *B. magalhaesii* (Fig. 5). Although the sculpturing of these two species shows a close resemblance, especially on the contents of their muri, one can differentiate the two species by the protrusions on the muri and in the lumina of *B. gentianoides*. The lumina of *B. stenophylla* are smaller than those of *B. gentianoides* and *B. magalhaesii*. Furthermore, the muri of *B. stenophylla* are much straighter and more solid, without any tendency towards the development of protrusions, than the other species.

In summary, the few pollen specimens included in this study indicate the potential of the stereoscan in enhancing certain characteristics in the systematics of the Velloziaceae. The success of any such studies depends largely upon the availability of suitable pollen and standardization of preparation techniques.

Literature Cited

Ayensu, E. S. 1968. The anatomy of *Barbaceniopsis*, a new genus recently described in the Velloziaceae. Amer. Journ. Bot. 55: 399–405.

———. 1969a. Leaf anatomy and systematics of Old World Velloziaceae. Kew Bull. 23(2): 315–335.

———. 1969b. The identity of *Vellozia uaipanensis*. Anatomical evidence. Mem. N. Y. Bot. Gard. 18(2): 291–298.

———. Photogeography and Evolution of the Velloziaceae. *In* Tropical forest ecosystems in Africa and South America. A comparative review. Ed. B. J. Meggers, E. S. Ayensu, and W. D. Duckworth, Smithsonian Press. In press.

Erdtman, G. 1963. Palynology. *In* Advances in Botanical Research I. Ed. R. D. Preston. Academic Press, London and New York.

Maguire, B. 1969. Velloziaceae. *In* Botany of the Guayana Highlands —Part VIII. Mem. N.Y. Bot. Gard. 18(2):36–41.

Smith, L. B. 1962. A synopsis of the American Velloziaceae. Contrib. U. S. Nat. Herb. 35: 251–292.

———, and E. S. Ayensu. Classification of the Old World Velloziaceae. Kew Bull. In press.